

## AN INTEGRATED SERVICES DIRECTOR (ISD) OVERALL ARCHITECTURE

### Field of the Invention

The invention relates generally to telephone communication systems and, more particularly, to a telephone network interface unit typically disposed on the outside of a home or small business.

### Background

As deregulation of the telephone industry continues and as companies prepare to enter the local telephone access market, there is a need to offer new and innovative services that distinguish common carriers from their competitors. This cannot be accomplished without introducing new local access network architectures that will be able to support these new and innovative services.

Conventionally, customer premises telephone and/or data connections contain splitters for separating analog voice calls from other data services such as Ethernet transported over digital subscriber line (DSL) modems. Voice band data and voice signals are sent through a communications switch in a central or local office to an interexchange carrier or Internet service provider. DSL data is sent through a digital subscriber loop asynchronous mode (DSLAM) switch which may include a router. The DSLAM switch connects many lines and routes the digital data to a telephone company's digital switch.

A major problem with this configuration is that interexchange carriers attempting to penetrate the local telephone company's territory must lease trunk lines from the local telephone company switch to the interexchange company's network for digital traffic. Furthermore, the Internet service provider must lease a modem from the local phone company in the DSLAM switch and route its data through the local phone company's digital switch. Thus, the local phone company leases and/or provides a significant amount of equipment, driving up the cost of entry for any other company trying to provide local telephone services and making it difficult for the interexchange companies to differentiate their services. Furthermore, since DSL modem technology is not standardized, in order to ensure compatibility, the DSL modem provided by the local telephone company must also be provided to the end user in the customer premises

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5 equipment (CPE). Additionally, since the network is not completely controlled by the interexchange companies, it is difficult for the interexchange companies to provide data at committed delivery rates. Any performance improvements implemented by the interexchange companies may not be realized by their customers, because the capabilities of the local telephone company equipment may or may not meet their performance needs. Thus, it is difficult for the interexchange companies to convince potential customers to switch to their equipment or to use their services. These factors ensure the continued market presence of the local telephone company.

10 As part of this system, there is a need for improved architectures, services and equipment utilized to distinguish the interexchange companies' products and services.

### Summary of the Invention

15 In order to provide an improved network, it is desirable for the interexchange companies to have access to at least one of the twisted-pair lines or alternate wireless facility connecting each of the individual users to the local telephone network before the lines are routed through the conventional local telephone network equipment. It is preferable to have access to these lines prior to the splitter and modem technology offered by the local service providers. By having access to the twisted-pair wires entering the customer's premises, interexchange companies can differentiate their services by providing higher bandwidth, improving the capabilities of the customer premises equipment, and lowering overall system costs to the customer by providing competitive service alternatives.

20 The new architecture may utilize a video phone and/or other devices to provide new services to an end user; an intelligent services director (ISD) disposed near the customer's premises for multiplexing and coordinating many digital services onto a single twisted-pair line; 25 a facilities management platform (FMP) disposed in the local telephone network's central office for routing data to an appropriate interexchange company network; and a network server platform (NSP) coupled to the FMP for providing new and innovative services to the customer and for distinguishing services provided by the interexchange companies from those services

provided by the local telephone network.

As part of this system, one aspect of the invention provides active components located in the network access unit such as a modem, multiplexer, and a controller.

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### **Brief Description of the Drawings**

The foregoing summary of the invention, as well as the following detailed description of preferred embodiments, is better understood when read in conjunction with the accompanying drawings, which are included by way of example, and not by way of limitation with regard to the claimed invention.

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Fig. 1 illustrates an embodiment of a hybrid fiber twisted pair local loop architecture.

Fig. 2 is a block diagram of an embodiment of an intelligent services director consistent with the architecture shown in Fig. 1.

Fig. 3A and 3B illustrate an embodiment of a video phone consistent with the architecture shown in Fig. 1.

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Fig. 4A is a block diagram of an embodiment of a facilities management platform consistent with the architecture shown in Fig. 1.

Fig. 4B illustrates a block diagram of an embodiment of a network server platform consistent with the architecture shown in Fig. 1.

Fig. 5 is a block diagram of an embodiment of the ISD.

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Figs. 6A and 6B are block diagrams of various frame structures which may be used to communicate between the ISD and the FMP.

Fig. 7A and 7B are examples of one signaling structure which may be used to initiate a call.

Fig. 8-10 are various embodiments of the ISD.

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Fig. 11 is an example of one protocol stack for use with the ISD.

Fig. 12 is a one exemplary embodiment of a form factor for the ISD.

### **Detailed Description of Preferred Embodiments**

Referring to Fig. 1, a first exemplary communication network architecture employing a hybrid fiber, twisted-pair (HFTP) local loop 1 architecture is shown. An intelligent services director (ISD) 22 may be coupled to a central office 34 via a twisted-pair wire, hybrid fiber interconnection, wireless and/or other customer connection 30, a connector block 26, and/or a main distribution frame (MDF) 28. The ISD 22 and the central or local office 34 may communicate with each other using, for example, framed, time division, frequency-division, synchronous, asynchronous and/or spread spectrum formats, but in exemplary embodiments uses DSL modem technology. The central office 34 preferably includes a facilities management platform (FMP) 32 for processing data exchanged across the customer connection 30. The FMP 32 may be configured to separate the plain old telephone service (POTS) from the remainder of the data on the customer connection 30 using, for example, a tethered virtual radio channel (TVRC) modem (shown in Fig. 4A). The remaining data may be output to a high speed backbone network (e.g., a fiber-optic network) such as an asynchronous transfer mode (ATM) switching network. The analog POTS data may be output directly to a public switch telephone network (PSTN) 46, and/or it may be digitized, routed through the high speed backbone network, and then output to the PSTN 46.

The FMP 32 may process data and/or analog/digitized voice between customer premise equipment (CPE) 10 and any number of networks. For example, the FMP 32 may be interconnected with a synchronous optical network (SONET) 42 for interconnection to any number of additional networks such as an InterSpan backbone 48, the PSTN 46, a public switch switching network (e.g. call setup SS7-type network 44), and/or a network server platform (NSP) 36. Alternatively, the FMP 32 may be directly connected to any of these networks. One or more FMPs 32 may be connected directly to the high speed backbone network (e.g., direct fiber connection with the SONET network 42) or they may be linked via a trunk line (e.g., trunks 40 or 42) to one or more additional networks.

The NSP 36 may provide a massive cache storage for various information that may be provided across the SONET net 42 to the FMP 32 and out to the ISD 22. The NSP 36 and the FMP 32 may collectively define an access network server complex 38. The NSP 36 may be

interconnected with multiple FMPs 32. Furthermore, each FMP 32 may interconnect with one or more ISDs 22. The NSP 36 may be located anywhere but is preferably located in a point-of-presence (POP) facility. The NSP 36 may further act as a gateway to, for example, any number of additional services.

5           The ISD 22 may be interconnected to various devices such as a videophone 130, other digital phones 18, set-top devices, computers, and/or other devices comprising the customer premise equipment 10. The customer premise equipment may individually or collectively serve as a local network computer at the customer site. Application applets may be downloaded from the NSP 36 into some or all of the individual devices within the customer premise equipment 10.

10       Where applets are provided by the NSP 36, the programming of the applets may be updated such that the applets are continually configured to the latest software version by the interexchange carrier. In this way, the CPE 10 may be kept up to date by simply re-loading updated applets. In addition, certain applets may be resident on any of the CPE 10. These resident applets may be periodically reinitialized by simply sending a request from, for example, a digital phone 18  
15       and/or a videophone 130 to the FMP 32 and thereafter to the NSP 36 for reinitialization and downloading of new applets. To ensure widespread availability of the new features made possible by the present architecture, the customer premise equipment may be provided to end users either at a subsidized cost or given away for free, with the cost of the equipment being amortized over the services sold to the user through the equipment.

20           Referring to Fig. 2, the ISD 22 may connect with a variety of devices including analog and digital voice telephones 15, 18; digital videophones 130, devices for monitoring home security, meter reading devices (not shown), utilities devices/energy management facilities (not shown), facsimile devices 16, personal computers 14, and/or other digital or analog devices. Some or all of these devices may be connected with the ISD 22 via any suitable mechanism such  
25       as a single and/or multiple twisted-pair wires and/or a wireless connection. For example, a number of digital devices may be multi-dropped on a single twisted-pair connection. Similarly, analog phones and other analog devices may be multi-dropped using conventional techniques.

          The ISD 22 may be located within the home/business or mounted exterior to the

home/business. The ISD 22 may operate from electrical power supplied by the local or central office 34 and/or from the customer's power supplied by the customer's power company. Where the ISD 22 includes a modem, it may be desirable to power the ISD 22 with supplemental power from the home in order to provide sufficient power to enable the optimal operation of the modem.

As shown in Fig. 2, in some embodiments the ISD 22 may include a controller 100 which may have any of a variety of elements such as a central processing unit 102, a DRAM 103, an SRAM 104, a ROM 105 and/or an internet protocol (IP) bridge router 106 connecting the controller 100 to a system bus 111. The system bus 111 may be connected with a variety of network interface devices 110. The network interface devices 110 may be variously configured to include an integrated services digital network (ISDN) interface 113, an Ethernet interface 119 (e.g., for 28.8 kbs data, 56 kbs data, or ISDN), an IEEE 1394 "fire wire" interface 112 (e.g., for a digital videodisc device (DVD)), a TVRC modem interface 114 (e.g., for a digital subscriber line (DSL) modem), a residential interface 114 (e.g., standard POTS phone systems such as tip ring), a business interface 116 (e.g., a T1 line and/or PABX interface), a radio frequency (RF) audio/video interface 120 (e.g., a cable television connection), and a cordless phone interface 123 (e.g., a 900 MHZ transceiver). Connected to one of the network interfaces and/or the system bus 111 may be any number of devices such as an audio interface 122 (e.g., for digital audio, digital telephones, digital audio tape (DAT) recorders/players, music for restaurants, MIDI interface, DVD, etc.), a digital phone 121, a videophone / user interface 130, a television set-top device 131 and/or other devices. Where the network interface is utilized, it may be desirable to use, for example, the IEEE 1394 interface 112 and/or the Ethernet interface 119.

A lifeline 126 may be provided for continuous telephone service in the event of a power failure at the CPE 10. The lifeline 126 may be utilized to connect the ISD 22 to the local telecommunications company's central office 34 and, in particular, to the FMP 32 located in the central office 34.

The ISD may be variously configured to provide any number of suitable services. For example, the ISD 22 may offer high fidelity radio channels by allowing the user to select a

particular channel and obtaining a digitized radio channel from a remote location and outputting the digital audio, for example, on audio interface 122, video phone 130, and/or digital phones 121. A digital telephone may be connected to the audio interface 122 such that a user may select any one of a number of digital audio service channels by simply having the user push a digital audio service channel button on the telephone and have the speaker phone output particular channels. The telephone may be preprogramed to provide the digital audio channels at a particular time, such as a wake up call for bedroom mounted telephone, or elsewhere in the house. The user may select any number of services on the video phone and/or other user interface such as a cable set-top device. These services may include any number of suitable services such as weather, headlines in the news, stock quotes, neighborhood community services information, ticket information, restaurant information, service directories (e.g., yellow pages), call conferencing, billing systems, mailing systems, coupons, advertisements, maps, classes, Internet, pay-per-view (PPV), and/or other services using any suitable user interface such as the audio interface 122, the video phone / user interface 130, digital phones, 121 and/or another suitable device such as a settop device 131.

In further embodiments, the ISD 22 may be configured as an IP proxy server such that each of the devices connected to the server utilizes transmission control protocol / internet protocol (TCP/IP) protocol. This configuration allows any device associated with the ISD to access the Internet via an IP connection through the FMP 32. Where the ISD 22 is configured as an IP proxy server, it may accommodate additional devices that do not support the TCP/IP protocol. In this embodiment, the ISD 22 may have a proprietary or conventional interface connecting the ISD 22 to any associated device such as to the set top box 131, the personal computer 14, the video telephone 130, the digital telephone 18, and/or some other end user device.

In still further embodiments, the ISD 22 may be compatible with multicast broadcast services where multicast information is broadcast by a central location and/or other server on one of the networks connected to the FMP 32, e.g., an ATM-switched network. The ISD 22 may download the multicast information via the FMP 32 to any of the devices connected to the ISD

22. The ISD 22 and/or CPE 10 devices may selectively filter the information in accordance with a specific customer user's preferences. For example, one user may select all country music broadcasts on a particular day while another user may select financial information. The ISD 22 and/or any of the CPE 10 devices may also be programmed to store information representing users' preferences and/or the received uni-cast or multicast information in memory or other storage media for later replay. Thus, for example, video clips or movies may be multicast to all customers in the community with certain users being preconfigured to select the desired video clip/ movie in real time for immediate viewing and/or into storage for later viewing.

Referring to Fig. 3A, a videophone 130 may include a touch screen display 141 and soft keys 142 around the perimeter of the display 141. The display may be responsive to touch, pressure, and/or light input. Some or all of the soft keys 142 may be programmable and may vary in function depending upon, for example, the applet being run by the videophone 130. The function of each soft key may be displayed next to the key on the display 141. The functions of the soft keys 142 may also be manually changed by the user by pressing scroll buttons 143. The videophone 140 may also include a handset 144 (which may be connected via a cord or wireless connection to the rest of the videophone and/or directly to the ISD), a keypad 150, a video camera 145, a credit card reader 146, a smart card slot 147, a microphone 149, a motion and/or light detector 148, built-in speaker(s) 155, a printer/scanner/facsimile 152, and/or external speakers 154 (e.g., stereo speakers). A keyboard 153 and/or a postage scale 151 may also be connected to the videophone 130. Any or all of the above-mentioned items may be integrated with the videophone unit itself or may be physically separate from the videophone unit. A block diagram of the video phone unit is shown in Fig. 3B. Referring to Fig. 3B, in addition to the items above, the video phone 130 may also include a signal processor 171, high speed interface circuitry 172, memory 173, power supply 174, all interconnected via a controller 170.

When the videophone 130 is used as a video telephone, the display 141 may include one or more video window(s) 160 for viewing a person to whom a user is speaking and/or showing the picture seen by the person on the other end of the video phone. The display may also include a dialed-telephone-number window 161 for displaying the phone number dialed, a virtual keypad



162, virtual buttons 163 for performing various telephone functions, service directory icons 165, a mail icon 164, and/or various other service icons 166 which may be used, for example, for obtaining coupons or connecting with an operator. Any or all of these items may be displayed as virtual buttons and/or graphic icons and may be arranged in any combination. Additionally, 5 any number of other display features may be shown on the video phone in accordance with one or more of the applications incorporated by reference below.

Referring to Fig. 4A, the FMP 32 may coordinate the flow of data packets, separate voice signals from other signals, perform line monitoring and switching functions, and/or convert between analog and digital signals. The FMP 32 may process data sent from the CPE 10 to the 10 central or local office 34 by separating and reconstructing analog voice signals, data, and control frames. The FMP 32 may process data sent from the central or local office 34 to the CPE 10 by separating control messages from user information, and configure this information into segments that for transport across the digital subscriber loop. The FMP 32 may also terminate the link layer associated with the digital subscriber loop.

15 In some embodiments, the FMP 32 may include an access module 70 and a digital loop carrier 87. The access module 70 may include a line protector 71, a cross-connector 73, a plurality of TVRC modems 80, a plurality of digital filters 82, a controller multiplexer 84, and/or a router and facilities interface 86. The digital loop carrier 87 may include a plurality of line cards 96, a time domain multiplexing (TDM) multiplexor (MUX) 88, a TDM bus 90, a controller 20 92, and/or a facilities interface 94.

During normal operations, digital signals on the customer connection 30 (e.g., twisted-pair lines) containing both voice and data may be received by the TVRC modems 80 via the line protector 71 and the cross-connector 73. Preferably, the line protector 71 includes lightning blocks for grounding power surges due to lightning or other stray voltage surges. The TVRC 25 modems 80 may send the digital voice and/or data signals to the controller multiplexer 84 and the digital filters 82. The digital filters 82 may separate the voice signals from the digital data signals, and the controller multiplexor 84 may then multiplex the voice signals and/or data signals received from the digital filters 82. The controller multiplexor 84 may then send multiplexed

voice signals to the TDM MUX 88 and the data signals to the router and facilities interface 86 for transmission to one or more external networks. The TDM MUX 88 may multiplex the voice signals from the controller multiplexor 84 and/or send the voice signals to the TDM bus 90, which may then send the digital voice signals to the controller 92 and then to the facilities interface 94 for transmission to one or more external networks. Both the router and facilities interface 86 and the facilities interface 94 may convert between electrical signals and optical signals when a fiber optic link is utilized.

When there is a failure of the digital data link (e.g., if there is a failure of the TVRC modems 80 at the FMP 32 or the TVRC modem 114 at the ISD 22), only analog voice signals might be sent over the subscriber lines 30. In such a case, the analog voice signals may be directly routed to the line cards 96, bypassing the TVRC modems 80, the digital filters 82, the controller multiplexor 84, and the TDM MUX 88. Thus, voice communication is ensured despite a failure of the digital data link. The line cards 96 may convert the analog voice signals into digital format (e.g., TDM format) and send the digitized voice data onto the TDM bus 90 and eventually through the controller 92 and the facilities interface 94 for transmission to one or more external networks.

Referring to Fig. 4B, the NSP 36 may be variously configured to provide any number of services provided by a server such as information services, Internet services, pay-per-view movie services, data-base services, commercial services, and/or other suitable services. In the embodiment shown in Fig. 4B, the NSP 36 includes a router 185 having a backbone 180 (e.g., a fiber distributed data interface (FDDI) backbone) that interconnects a management server 182, an information/database server 183, and/or one or more application server clusters 184. The NSP 36 may be connected via the router 185 by a link 181 to one or more external networks, NSPs 36, and/or an FMPs 32. The information/data base server 183 may perform storage and/or database functions. The application server cluster 184 may maintain and control the downloading of applets to the ISD 22. The NSP 36 may also include a voice/call processor 186 configured to handle call and data routing functions, set-up functions, distributed operating system functions, voice recognition functions for spoken commands input from any of the ISD

connected devices as well as other functions.

Again referring to Fig. 2, the ISD will now be explained in more detail. The ISD enables the seamless integration of voice and data across the telephone network. The ISD utilizes leverages interface and networking innovations originally developed to expedite information retrieval via the World Wide Web. When applied to telecommunications access, these advances enable a revolutionary change in service delivery, that makes the telephone companies network a much more valuable asset than ever before. Coupled with the introduction of low-cost premises devices (e.g., browser based touch-screen phones), the technology enables a natural and compelling link to a rich new class of service offerings and features such as CD quality voice, far more friendly access to a wide range of telephony services (CLASS, conferencing, messaging, emergency services, etc.), new non-traditional services on an AT&T secure intranet such as Bill payment, Banking, Electronic shopping, Home-based smart card ATM transactions, Electronic coupons, Interactive advertising / Point-casting, Corporate LAN extensions for Work-at-Home, Interactive multimedia telephony, High-speed access to the Internet even without a PC, restaurant ordering, sports ticket ordering, catalogue ordering, mail metering machines, directory services, customer services, rate tables, calling plan options, as well as self provision new services, get credit for wrong number calls, vastly reducing the number of service representatives required.

The ISD performs intelligent multiplexing, dynamic bandwidth allocation, and routing of voice and data and may also include advance signal processing for enabling voice activated commands. Because AT&T has over 90 million customers, it may be possible to give the video phone away for free so that all house-holds regardless of income level or desire to purchase a personal computer will have access to the vast information resources of the Internet, AT&T's networks, and/or third party networks including those providing pay per view (PPV) movie content and broadcast networks. It is anticipated that the video phone concept together with the ISD, FMP, and NSP of the present invention will revolutionize the delivery of telephony services and provide a quantum leap in the paradigm of

telecommunications, improving the quality of life of our customers while turning the copper loop into an increasing necessity for all users.

For high end residential consumers who want more convenience and simplicity in their daily lives and convenient access to more information devices coupled to the ISD provide, for example: easier delivery of a wider range of telephony services (e.g., customer care, marketing, operator services) with cost savings due to automation; new service opportunities such as interactive electronic catalog shopping from the home, and advertising; ability to offer ultra fast Internet access to every household, penetrating even those without a PC unlike traditional voice / touch tone telephony access; high fidelity voice and music; touch screen and/or voice activated customer interface; asymmetric high speed transport of data to the home with the asymmetric character of the link and apportionment of that bandwidth variable depending on the amount of traffic; new service opportunities such as 3rd party bill payment including paper-less bill payment, banking, obtaining smart card cash in an ATM transactions, electronic shopping from the home, electronic coupons, advertising, electronic review and payment of bills, calling plans, class of services, as well as other services and plans; Interactive video teleconferencing; state-of-the-art networking for Work-at-Home; private line services; Call Connection including the self scheduling of conference calls without the need for an operator as well as initiation of interactive calls with white board augmentation using an appropriate applet downloaded from the NSP; class services invoked, for example, via icons and prompts in a natural manner without requiring memorization of numerical codes; navigation & access for voice, e-mail, and fax messages; obtain operator services without an operator, credit for wrong number, rate table, etc.; define profile for pointcast services; purchase products advertised on TV via synchronized ordering screen with television or PPV shows; Multimedia Enhanced Voice Calls, interactive voice & data response applications & info- on-demand; Support for work-at-home via virtual WAN; Screen pops for message/call alerting; graphical call management using touch and/or a mouse interface, including, for example call setup/bridging capabilities and point-and-click/tap-and-

drag conferencing graphical user interfaces to initiate POTS calls, personal registry, mobility manager, call scheduling, call me back standard messages, personal assistant; Universal Multimedia Mailbox including a common interface for fax, voice, text, audio, and/or audio/visual images; 7 KHz high fidelity voice; asymmetric high speed transport with dynamic bandwidth allocation; residential LAN interface and associated local area network within the home; interactive video teleconferencing, display of web pages for customers placed on-hold, and other applications as discussed herein.

The service in accordance with aspects of the present invention makes the phone lines a conduit for a wide variety of high revenue service offerings, allows the differentiation of local telephone and long distance telephone services, significantly reduces operation costs, extracts additional performance benefits from the imbedded loop plant, makes maximum use of the existing network infrastructure, and uniquely leverages new technology. Aspects of the present invention will enable a revolutionary change in service delivery, which can greatly improve the quality of people's lives, and make the telephone network a much more valuable asset than ever before. When coupled with the introduction of low-cost premises devices (e.g., touch-screen phones), the technology enables a natural and compelling interface to rich new classes of service offerings for all telephone users regardless of their ability or desire to afford a personal computer or learn. Thus AT&T can reduce the cost of its own billing while making it easier for the customer to pay the bill. Additionally electronic billing services can be offered to other companies.

The ISD may be physically located on the premises side of the protector block. In exemplary embodiments as shown in Fig. 2, the ISD terminates the twisted-pair loop facilities leased from the local exchange carrier on the network side and the premise equipment and associated networks on the premises side. The ISD may operate to aggregate the diverse traffic from the customer premise equipment onto a single stream for transmission over the loop to the Facilities Management Platform (FMP) and to de-multiplex the traffic from the FMP.

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A basic Premises Distribution Network (PDN) 500 for one exemplary embodiment of a typical residential application of the ISD 22 is shown in Fig. 5. The premise distribution network 500 may include one or more Ethernet connections 500 for connecting a plurality of devices such as a number of personal computers 14A, 14B, a vision phone, and/or other devices. Further, the premise distribution network 500 may include any number of conventional analog lines 505 (e.g., Tip/Ring (T/R) phone lines), each having one or more associated analog phones (e.g., 15A - 15n), and/or associated PCs with modem and/or phone cards. Further, the premises distribution network 500 may include any number of ISDN lines 506, each having any number of digital appliances such as ISDN compliant devices and/or video phones 130. The premises distribution network 500 may use existing twisted pair telephone line and/or may utilize a special cable to facilitate Ethernet and/or other LAN connections. Where the video phone 130 shares the same LAN as a connected PC 14A, prioritization software in the LAN driver gives priority to video and/or audio transmissions to and from the video phone to reduce latency time and unpredictable delays. Alternatively, the video phone 130 may be coupled via a dedicated ISDN connection, a dedicated ethernet connection, and/or another dedicated connection to the ISD 22. The video phone may have an integrated analog phone for life line support. Alternatively, one of the analog phones serves the function of providing lifeline support. Where the video phone 130 includes lifeline support, it is preferred to transmit data to the phone in a band above 7 KHz using ADSL like modem technology.

In exemplary embodiments, the ISD 22 multiplexes traffic from the various components of the PDN 500 (e.g., Ethernet, Screen Phone, Tip/Ring, ISDN) either between other devices on the PDN and/or onto DSL modem 114 for transport over loop twisted pair to the Central Office. The DSL modem may be constructed using any of the techniques described in the applications incorporated by reference below. Within the scope of the current document, the term xDSL will be used to represent any member of the DSL family. This family comprises, High Speed Digital Subscriber Line (HDSL), Asymmetric Digital Subscriber Line (ADSL),

Symmetrical Digital Subscriber Line (SDSL) and Very high data rate Digital Subscriber Line (VDSL). This list is not limited to the members described herein, since changing technology adds more DSL schemes.

5 The ISD 22 may execute any number of additional telephony functions using known techniques such as Packetization of voice for all telephone calls, Tip/Ring Borscht functions, default to Central Office Battery/Tip/Ring to provide lifeline service during power failure, overvoltage Protection, ringing, supervision, answer and incoming call/ringing supervision, generation of call progress tones (e.g., dial tone, busy, ringback, invalid number, etc.), various coding such as 7 KHz G.722 coding for Electra called parties, 3.3. KHz mu-law  
10 coding for non-ISD enabled parties, transmit messages reporting DTMF, on hook/off hook/flash hook events, support for voice dialing and enablement of special calling features (e.g., through the use of processor 102 which may include signal co-processor 102A and/or a high performance controller such as the 8960), provision of dial tone with time-out for voice dialing service, coding /forwarding voice commands (e.g., to a voice processor in the  
15 FMP and/or NSP.

The data link protocol of the DSL modem may be variously configured to include incorporate Forward Error Correction for traffic unsuited to re-transmission such as voice traffic. Additionally, the data link protocol may organize the aggregate data stream created by multiplexing downstream channels, duplex channels, and maintenance channels together  
20 into blocks, attaching an error correction code to each block. The receiver then can correct errors that occur during transmission up to the limits implied by the code and the block length. The data link protocol may also provide sufficient interleaving to correct errors due to impulsive noise but supporting low latency for voice traffic, create superblocks by interleaving data within subblocks to allow the receiver to correct any combination of errors  
25 within a specific span of bits. It may be desirable to tailor the interleaving interval to the latency budget for voice applications in DSL modems utilized to carry voice as in the present invention.

5 The packet handling in the present system may be variously configured. For example, in the CPE-Network direction, a the processor 102 may be configured to act as a packet handling subsystem to processes frames from the FMP and to generate DSL frames going to the FMP. The ISD and the FMP include DSL modems (e.g., TVRC) modems to terminate the link layers associated with the DSL segment of the connection. In a similar manner as the FMP, the processor in the ISD may be configured to reconstruct the IPv6 packets from DSL frames and then separates IP packets containing voice from those containing data and from those containing signaling. In the ISD, speech packets from the Packet Handling subsystem may be delivered to the residential interface for output to one or more analog lines to create virtual phone lines using the upper bandwidth of the DSL modem (e.g., 40Khz to 1Mhz) in a similar manner as the packet-to-circuit translation subsystem which may be utilized in the FMP. The processor 102 in the ISD 22 may also be configured to generate signaling packets which may be forwarded to the FMP for later utilization in either an in-band or out-of-band routing subsystem such as a conventional subscriber signaling subsystem (e.g., TR 303). Similarly, the processor 102 in the ISD 22 may include a subscriber signaling subsystem as part of an external routing subsystem. In this manner, packets received from the FMP in the network-CPE direction (including voice, data, video, and control packets) may be demultiplexed, reformatted with an appropriate protocol, and output to an attached peripheral device connected to the premise distribution network 500.

20 In the network to CPE direction, the processor 102 may be configured to re-construct IPv6 packets from DSL frames, and separating IP packets containing voice from those containing data from those containing signaling.. This process may involve, for example, multiplexing (at the IP packet level) voice, data and subscriber signaling packets bound for a single DSL link with IP packets mapped onto DSL frames.

25 The processor 102 may also include one or more signal processors 102A and/or voice processor to perform various MPEGII coding/decoding functions, codec functions, voice recognition functions, etc. The processor 102 may also be configured to perform various



protocol conversion functions such that data having protocols used on a device connected to the premise distribution network may be efficiently transmitted to and from the FMP using an appropriate transmission protocol. Additionally, the processor 102 monitors the devices connected to the premise distribution network and stores information concerning which devices are currently in use. In this manner, where there is an incoming call, the ISD has the intelligence to know which CPE is in use and which CPE is not in use. As a result, if there is an incoming call, the ISD will not send a ringing tone to any CPE that is already in use, but will route the call to another device that is available. Further, where there is a choice of a plurality of phones and/or other devices to route the call, the ISD may review activity detected on the motion sensors on any attached motion sensing devices such as those which may be present in a video phone 130 and ring a phone which is most convenient to the user. As an alternative, all available phones will be rung, with the user given the option to switch between incoming lines.

In an exemplary embodiment shown in Fig. 5, where an incoming call arrives at the ISD 22, the control 510 rings one or all of the attached phones. Where a user answers a first phone (e.g., 15A), the utilization of this phone is recorded. Thereafter, the user may continue talking on this phone and an off-hook status is indicated. Where another call comes in, the user may choose to answer this call via a conventional method such as "call waiting" and/or using multiple lines. Further, the answering machine (described in an attached application) may be configured to indicate that the user is receiving an incoming call at the moment and provide an on-hold menu as discussed in the applications incorporated by reference below. The control 510 may be configured to have a plurality of calls on-hold and toggle between these calls by depressing a DTMF key and/or the hang-up actuator. Alternatively, a digital phone and/or video phone 130 may have any number of lines with a name, address, and phone number associated with each of the incoming callers. Thus, the residential interface module allows multiple virtual analog phone lines to be multiplexed on a single twisted pair phone line. Further, one of the phone lines may be provided with life line support.

Interconnected to the ISD may be a protector block 26 which is used for impedance

matching. The protector block 26 may also act as a demarcation of the customer premise and the local loop transmission network. Copper twisted pair may be utilized to connect the protector block and a Main Distribution Frame (MDF) as the main transmission medium in the local loop.

The DSL modems shown as 114 may be implemented using a Tethered Virtual Radio Channel (TVRC) modem as discussed in the applications incorporated herein by reference. The TVRC (Tethered Virtual Radio Channel) engine may be implemented using a simultaneous voice-data modem which may be a full-duplex Variable Rate - Adaptive Digital Subscriber Line (VR-ADSL) modem. The modem may transmit and receive the modulated voice + data bit stream via the twisted pair. The modem uses discrete multi-tone (DMT) modulation to achieve at least 1.5 Mbps data rate in both directions. Some of the TVRC engine functions include forward error control (Reed Solomon), channel coding (Turbo or Wei Convolution), TVRC spreading, echo cancellation and analog transmit/ receive line interfacing. The TVRC modem may be implemented using one or more programmable DSPs which may be utilized to provide the modem transmit FFT and/or receive IFFT engine. However, the embodiments of aspects of the instant invention are not limited to the use of TVRC modulation technology. However, TVRC may be desirable as an alternate to interleaving in order to overcome impairments such as noise and interference and which results in unacceptable delays.

The processor 102 in the ISD 22 may be configured to discriminate between the various forms of traffic and to route this traffic to an appropriate device. Where high priority voice and/or video is distributed across the interface, the ISD may include one or more priority queues disposed in the SRAM and/or DRAM 103, 104. There may be different priority queues for each connected device on the premise distribution network (including any attached device described with regard to Fig. 2 or discussed herein). Additionally, there may be different queues for each device in both the transmit and receive direction. Further, control and signaling information may be assigned various levels of priority. A similar queue structure may also be implemented in the FMP. In one exemplary embodiment, the queues give priority to signaling information, and voice information for the various attached telephones. If a queue is in danger of overflow, flow

control mechanisms may be utilized by the ISD and/or FMP. Voice data is accessed first using an appropriate queuing scheme such as priority fair weighted queuing or another suitable scheme. In addition to queuing, bandwidth may be varied so that more DSL frames are assigned to voice and/or video than data. Further, asymmetric DSL protocols may be dynamically implemented such that more bandwidth may be allocated to one direction or the other as necessary. Where one ISD 22 is serving as the node for, for example, a seven way conference call, the outgoing bandwidth for the node may need to be increased relative to the incoming bandwidth. However, where a PPV movie and/or Internet file is being downloaded, the bandwidth may be reversed such that more bandwidth is available from the network to the CPE equipment. Thus, asymmetric high speed transport of data to the home with the asymmetric character of the link and apportionment of that bandwidth variable depending on the amount of traffic results in a substantially more flexible platform to implement advanced services to the user. Multiple modem protocols may be downloaded into the DSL modem dynamically to chose the best protocol for a particular dynamic bandwidth allocation to maximize the amount of through put.

For example, with reference to Fig. 6, information may be multiplexed into one or more DSL frames in order to dynamically allocate bandwidth. In one exemplary embodiment, where data is being input to one of the connected data devices (e.g., a PC), and a voice call comes in, a dynamic allocation of bandwidth may occur. Assume that 1 Mbps is available for information transfer. Prior to the incoming call, all 1 Mbps may be completely used for the data transmission. However, as soon as a voice call comes in, since voice has a higher priority than data, a 64 Kbps channel is deallocated from data usage and is allocated for voice. If a second voice call comes in, then another data channel will be deallocated from data usage and allocated for voice. As a voice call gets terminated, then the allocated voice slots will be reallocated to use by data and/or another voice channel. For example, as shown in Fig. 6B, voice call 4 V4 is terminated and the bandwidth is reallocated to D3. Accordingly, as the bandwidth is reallocated, the header may be updated to reflect the new bandwidth allocation. This allocation may occur

in both the CPE to network traffic and network to CPE traffic. Additionally, as slots are added to CPE to network traffic, slots may be deallocated to network to CPE traffic implementing a dynamic asymmetric bandwidth allocation. Hence, the system dynamically allocates bandwidth in real time to maximize information transfer. Where individual packets are used to transport voice and data between the ISD 22 and the FMP 32, an individual channel does not need to be allocated. Voice packets are simply given priority over data packets in the transfer. Therefore, silence periods may be used to the advantage and a higher overall bandwidth occurs. Data is simply stored in the buffer and/or slowed in its transfer using standard flow control where voice has priority. In aspects of the present invention, bandwidth may be allocated on a per-frame basis. By contrast, conventional systems only allocated bandwidth at the time a session is initiated - and once initiation has been completed, bandwidth allocation cannot be changed without tearing down the call. However, in aspects of the present invention, bursty data may be accommodated more efficiently since the burst data rate may be accommodated via dynamic bandwidth allocation.

The DSL modem 114 may be variously configured to supporting transport over 18000 foot loops at following rates exceeding 1 Mbits/second, and may include adapting duplex and downstream bit-rates to the needs of the current traffic such that more bandwidth is provided to the upstream and/or downstream and/or between various devices based on an intelligent bandwidth allocation algorithm. The DSL modem may provide a single-tone DMT mode for low power operation during idle periods to avoid re-synchronization at next service request and enable "always on" functionality. The always on and/or virtually always on functionality allows voice/data calls to be established virtually instantaneously without long delays. The virtually always on functionality allows the channel bandwidth to adapt to the current needs of the system to minimize power consumption, reduce thermal dissipation, and generate less interference. For example, if no device is currently being utilized, only a very low bandwidth channel is required. Accordingly, by reducing the bandwidth available across the loop, it is possible to improve overall performance for other lines.

The present invention discloses a local loop architecture that can overcome many of the Amongst the claimed advantages is the ability to have multiple appearances of a call on a single twisted pair. The architecture also allows data and voice to be mixed and bandwidth can be dynamically allocated in real time.

5 To illustrate the interaction between the various components of the instant invention, a voice dialing scenario will be described. When a subscriber picks up the telephone and if no digits have been dialed after a specified period of time has elapsed, the ISD may start digitizing the voice information into 64 Kbps  $\mu$ -law PCM data. The samples may be interpreted locally using processor 102 and converted into commands, and/or stored in a wave file for later  
10 transmission. For example, where the voice commands are saved, they may be subsequently transmitted to the FMP over a signaling channel. On receipt by the FMP, the FMP may either interpret the commands (e.g., using a controller in the controller and multiplexer 84), and/or forward the information to the NSP for further processing. In the NSP, the commands may be interpreted using known voice recognition technology. The NSP may attempt to authenticate  
15 the request by ensuring that the subscriber does indeed have a subscription to the voice dialing service. The NSP may then determine the identity of the subscriber by looking at the address in the IP field of the packet. The NSP can therefore interpret the information in the wave files and take the appropriate action.

In one illustrative example, assume that subscriber John wanted to call another subscriber  
20 Paul. The NSP may attempt to determine who is Paul as defined by John. Once the telephone number for John has been determined, the NSP may inform the FMP to set up a call to John's number. In some configurations, this may be done by the FMP using the TR303 interface (as shown in Fig. 7A and Fig. 7B), for example, by sending a signal to a SLC to request the local Serving Office to tell the latter the appropriate ports to use for setting up the call. The FMP may  
25 also include its own DTMF and tone generator for signaling. The inclusion of a DTMF tone generator in the FMP and/or ISD has significant advantages in that a voice dialing service may be provided by the interexchange companies and there is no need to pay for the Local Exchange

Carrier (LEC) for providing such a service. Similar services, such as speed dialing, that the LEC provides can now be made available locally using the ISD and/or FMP.

In the case where there is an incoming call, say from the PSTN, the FMP may obtain signaling information from the SLC. The information may be dispatched over the signaling channel to the NSP. The NSP may instruct the FMP with information on how the call should be terminated. On receiving this message, the FMP may send the appropriate signaling message to the ISD. The ISD may be configured to know which phones are in use and which ones are not. As a result, the ISD may apply ringing voltage to a phone that is not in use and/or take other remedial action as discussed above, e.g., using a call waiting signal.

The ISD may be configured to facilitate multiple appearances of calls on a single twisted pair to integrate voice and data traffic. The ISD is unlike conventional system that uses bandpass filters or splitter to separate voice and data. The ISD provides a local smart hub interface for all lines in the home as well as providing digital communication coordination among different devices in the home. The ISD may be configured for various functions including an alarm system, utility meter monitoring, standard POTS phone systems such as tip ring, or multiple tip rings, or multiple tip rings assigned to a single number, and/or multiple tip rings assigned to unique numbers, detection generation and conversion of DTMF tones, ring generation, off hook generation, and other call progress indication, and/or a business interface such as a T1 line, and/or other analog and/or digital lines.

Of course, other embodiments of the ISD will be apparent to those skilled in the art. For example, as shown in Figs. 8-10, a second exemplary example of the ISD is shown.

Further, various implementations of the ISD may be utilized in different implementations. For example, settop 513 may be coupled to any suitable interface such as the IEEE 1394, RF audio/video interface 120, ethernet interface 119, etc. A TV may be coupled to the settop. Additionally, a DAT, DVD and/or other audio device 515 may be coupled to the ISD using a suitable interface.

Referring to Fig. 11, various protocol stacks may be utilized to transmit the voice and data. For example, a voice signaling stack such as in-band voice over ATM and/or other voice signaling stack may be used. Additionally, a ether net and/or other IP stack may be utilized.

Referring to Fig. 12, the ISD may be included in a network interface unit. The network interface unit may be variously mounted either inside and/or outside of the house. Where a DSL modem and/or ISD is incorporated in the NIU 600, it may be desirable to mount the unit external to the home to allow access for service and to upgrade the ISD without entering the user's home. Alternatively, the NIU 600 may be provided within the home where power is more readily available and where temperature is more stable. Auxiliary power may be provided via an outlet within the house via a direct power link 612 and/or via a step-down transformer 613 connected to the ISD 22 via one or more twisted pair phone lines from within the house to outside of the house to the NIU via a spare twisted pair 614. The auxiliary link allows easy retrofit of existing NIUs 600. Phone lines and/or other interface lines may be provided from the ISD 22 to the house via lines 620 (e.g., twisted pair cabling). The cordless interface 123 of the ISD 22 may include a antenna 630, e.g., a 900 Mhz antenna mounted to the exterior of the NIU 600. The antenna 630 may be used as a cellular base station for other wireless devices associated with other customer premises. Further, a cable 630 may be associated with RF audio/video interface 120 in the ISD 22. The cable 630 may be coupled to a set-top and/or a TV 514.

The following applications, filed concurrently herewith, are hereby incorporated by reference:

1. A Hybrid Fiber Twisted-pair Local Loop Network Service Architecture (Serial Number 09/001,360);
2. Dynamic Bandwidth Allocation for use in the Hybrid Fiber Twisted-pair Local Loop Network Service Architecture (Serial Number 09/001,425);

3. The VideoPhone (Serial Number 09/001,905);
4. VideoPhone Privacy Activator (Serial Number 09/001,909);
5. VideoPhone Form Factor (Serial Number 09/001,583);
6. VideoPhone Centrally Controlled User Interface With User Selectable Options (Serial Number 09/001,576);
7. VideoPhone User Interface Having Multiple Menu Hierarchies (Serial Number 09/001,908);
8. VideoPhone Blocker (Serial Number 09/001,353);
9. VideoPhone Inter-com For Extension Phones (Serial Number 09/001,358);
10. Advertising Screen Saver (Serial Number 09/001,574);
11. Information Display for Visual Communication Device (Serial Number 09/001,906);
12. VideoPhone Multimedia Announcement Answering Machine (Serial Number 09/001,911);
13. VideoPhone Multimedia Announcement Message Toolkit (Serial Number 09/001,345);
14. VideoPhone Multimedia Video Message Reception (Serial Number 09/001,362);
15. VideoPhone Multimedia Interactive Corporate Menu Answering Machine Announcement (Serial Number 09/001,575);
16. VideoPhone Multimedia Interactive On-Hold Information Menus (Serial Number 09/001,356);
17. VideoPhone Advertisement When Calling Video Non-enabled VideoPhone Users (Serial Number 09/001,361);
18. Motion Detection Advertising (Serial Number 09/001,355);
19. Interactive Commercials (Serial Number 09/001,578);

09/001,906



20. VideoPhone Electronic Catalogue Service (Serial Number 09/001,421);
21. A Multifunction Interface Facility Connecting Wideband Multiple Access Subscriber Loops With Various Networks (Serial Number 09/001,356);
22. Life Line Support for Multiple Service Access on Single Twisted-pair (Serial Number 09/001,343);
23. A Network Server Platform (NSP) For a Hybrid Fiber Twisted-pair (HFTP) Local Loop Network Service Architecture (Serial Number 09/001,582);
24. A Communication Server Apparatus For Interactive Commercial Service (Serial Number 09/001,344);
25. NSP Multicast, PPV Server (Serial Number 09/001,580);
26. NSP Internet, JAVA Server and VideoPhone Application Server (Serial Number 09/001,354);
27. NSP WAN Interconnectivity Services for Corporate Telecommuting (Serial Number 09/001,540);
28. NSP Telephone Directory White-Yellow Page Services (Serial Number 09/001,426);
29. NSP Integrated Billing System For NSP services and Telephone services (Serial Number 09/001,359);
30. Network Server Platform/Facility Management Platform Caching Server (Serial Number 09/001,419);
31. An Integrated Services Director (ISD) Overall Architecture (Serial Number 09/001,417);

09/001,426

32. ISD VideoPhone (Customer Premises) Local House Network (Serial Number 09/001,418);
33. ISD Wireless Network (Serial Number 09/001,363);
34. ISD Controlled Set-Top Box (Serial Number 09/001,424);
35. Integrated Remote Control and Phone (Serial Number 09/001,423);
36. Integrated Remote Control and Phone User Interface (Serial Number 09/001,420);
37. Integrated Remote Control and Phone Form Factor (Serial Number 09/001,910);
38. VideoPhone Mail Machine (Attorney Docket No. 3493.73170);
39. Restaurant Ordering Via VideoPhone (Attorney Docket No. 3493.73171);
40. Ticket Ordering Via VideoPhone (Attorney Docket No. 3493.73712);
41. Multi-Channel Parallel/Serial Concatenated Convolutional Codes And Trellis Coded Modulation Encode/Decoder (Serial Number 09/001,342);
42. Spread Spectrum Bit Allocation Algorithm (Serial Number 09/001,842);
43. Digital Channelizer With Arbitrary Output Frequency (Serial Number 09/001,581);
44. Method And Apparatus For Allocating Data Via Discrete Multiple Tones (Serial Number 08/997,167); and
45. Method And Apparatus For Reducing Near-End Cross Talk In Discrete Multi-Tone Modulators/Demodulators (Serial Number 08/997,176).

The present application is #31 on the above list.

In addition, the following two patent applications are hereby incorporated by reference:

1. U.S. Patent Application 08/943,312 filed October 14, 1997 entitled Wideband Communication System for the Home, to Robert R. Miller, II and Jesse E. Russell, and
2. U.S. Patent Application No. 08/858,170, filed May 14, 1997, entitled Wide Band Transmission Through Wire, to Robert R. Miller, II, Jesse E. Russell and and Richard R. Shively.

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While exemplary systems and methods embodying the present invention are shown by way of example, it will be understood, of course, that the invention is not limited to these embodiments. Modifications may be made by those skilled in the art, particularly in light of the foregoing teachings. For example, each of the elements of the aforementioned

embodiments may be utilized alone or in combination with elements of the other embodiments.

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